

The Dietary Guidelines: Surveillance Issues and Research Needs

Keep Food Safe to Eat: Healthful Food Must Be Safe as Well as Nutritious¹

Catherine E. Woteki, Sandra L. Facinoli^{*2} and Danielle Schor^{*}

Under Secretary for Food Safety, U.S. Department of Agriculture, Washington, DC and ^{*}Food Safety and Inspection Service, U.S. Department of Agriculture, Washington, DC

ABSTRACT The inclusion of food safety in the 2000 edition of the *Dietary Guidelines for Americans* is an important step toward ensuring their continued relevance for health promotion and disease prevention. The inclusion of food safety is consistent with the original intent of the *Guidelines* and the increased focus on food safety today; it also better reflects current knowledge about diet and long-term health. A wide spectrum of surveillance methods can be used to monitor progress in reducing the incidence of foodborne illness, from surveys of food safety attitudes to epidemiologic data on foodborne illness. Surveillance data show that progress is being made, but that much work remains to be done. Strategies for reducing foodborne illness require a farm-to-table approach and the involvement of all those who have a responsibility for food safety, i.e., government, industry and the public. Federal agencies and others are finding it useful to use a risk analysis framework, i.e., risk assessment, risk management and risk communication, as a means of organizing available information, identifying data gaps, quantifying risks for specific pathogens and foods, and presenting strategies for improvement. Food safety education is a critical part of the overall strategy to reduce the incidence of foodborne illness and complements regulatory, research and other activities. J. Nutr. 131: 502S–509S, 2001.

KEY WORDS: • food safety • *Dietary Guidelines for Americans* • foodborne illness • risk analysis

Guidance of consumers toward nutritionally adequate diets must include research-based knowledge on food management procedures and preparation of foods for the table, to assure retention of both nutritional and eating qualities and to avoid foodborne illness (Senate Select Committee on Nutrition and Human Needs, United States Congress, 1977) (1).

The *Nutrition and Your Health: Dietary Guidelines for Americans* are important for two major reasons—first, they serve as a tool for educators, and second, they serve as a guide in setting food and nutrition policies. In these two roles, they have remained a success over the past 20 years because they are relevant and kept up to date by expert review. The inclusion of food safety in the 2000 edition is an important step toward ensuring their continued relevance for health promotion and disease prevention (2).

The incorporation of food safety into the *Dietary Guidelines for Americans* makes sense for four basic reasons. First, it is consistent with the both the original intent of the *Dietary Guidelines* as well as the growing focus on food safety we are seeing today. The report of the Senate Select Committee on Nutrition and Human Needs about the Dietary Goals for the United States, the predecessor document of the *Dietary Guide-*

lines, states that consumer guidance must “assure retention of both nutritional and eating qualities and . . . avoid foodborne illness” (1). The original *Dietary Guidelines* were designed to help Americans choose diets that will meet nutrient requirements, promote health, support active lives and reduce chronic health risks. Today, food safety is receiving more attention by government, the biomedical community and the public. The increased government focus is evidenced by a number of initiatives. In 1997, President Clinton announced his Food Safety Initiative, which provided needed funds for improvements in surveillance, inspection, research, risk assessment, outbreak response and education. In 1998 this was followed by the establishment of the President’s Council on Food Safety, which is charged with coordinating government-wide food safety activities. In addition, food safety has had a more explicit focus than ever before in Healthy People 2000 and 2010 Objectives (3). Healthy People is a government program that sets goals every 10 years for a variety of health concerns, including targets for the reduction of foodborne illness.

Second, by including food safety, the new *Dietary Guidelines* better reflect current knowledge about diet and long-term health. Much more is known now about the extent of foodborne illness and how severe it can be, not just in terms of acute illness, but also in terms of long-term chronic disease (4). The ability of foodborne illness to cause chronic complications is receiving new appreciation. In addition, there is a growing segment of the population, i.e., pregnant women, the elderly, the very young and individuals who are immunocom-

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² To whom correspondence should be addressed. E-mail: sandy.facinoli@usda.gov.

promised, that is particularly susceptible to foodborne illness (5). Vulnerable individuals become ill more readily and are likely to have more serious illnesses and complications.

Third, nutrition and food safety are intertwined, and there are many examples of this association. Foodborne pathogens can affect nutritional status by reducing appetite and the absorption of nutrients from the gut. Short-term diarrheal diseases are associated with a sudden loss of some enzyme activity such as lactase, which is important to the digestion and absorption of lactose in dairy products. Conversely, dietary advice can have food safety implications. The "Eat 5 A Day for Better Health" Program (6) promotes the consumption of fruits and vegetables, but there are public health concerns about the safety of these products in terms of microbial contamination (7). For example, there are reports of increasing numbers of illnesses associated with the consumption of raw sprouts contaminated with *Salmonella* and *Escherichia coli* O157:H7 (8). Many other nutritious foods are associated with food safety problems. Even properly cooked meats, considered low-risk foods, can cause illness under certain circumstances, such as when food handlers allow raw meat juices to contaminate other foods. This does not mean that such foods should be avoided; the benefits outweigh the risks associated with their consumption. Rather, it means that nutrition and food safety education should go hand in hand when there are tangible steps consumers can take that will reduce the risk of foodborne illness.

The fourth reason food safety has a place in the *Dietary Guidelines* is that foodborne disease is partially preventable through public education; for that reason, government has an obligation to use this strategy to reduce foodborne illness. As the Dietary Guidelines Advisory Committee indicated in its report, the guideline on keeping food safe to eat is a "step in unifying and strengthening the focus of the *Dietary Guidelines* on actionable measures that can be taken by consumers and public health officials to keep Americans healthy" (9). Education is not a substitute for, but complements other government activities such as regulation and research.

Challenges related to food safety education

The development of food safety messages faces some of the same challenges faced by the development of nutrition messages in that they are subject to change based on new research and new developments. For example, new products in the marketplace, such as prepared salads and other deli items, are convenient for busy consumers; because they require more handling, however, both at federally inspected facilities and at retail locations, an increased opportunity exists for them to be contaminated with pathogens (10). The emergence of pathogens, such as *E. coli* O157:H7, and the reemergence of others, such as *Listeria monocytogenes*, require new regulatory approaches as well as new behaviors by susceptible populations.

The increasingly global nature of the food supply has led to the introduction of pathogens into the U.S. food supply that were not previously known here, such as *Cyclospora* in Guatemalan raspberries (11). In addition, the centralized nature of the food distribution system exposes a far larger number of people over a wider geographical area to contaminated products. New agricultural production methods also affect food safety. The upsurge in organic farming is good for the environment and helps reduce the contamination of food products with potentially harmful levels of chemical residues (12). However, there are public health concerns about the fact that pathogens such as *E. coli* O157:H7 can survive 30–60 days in composted manure used on crops (13), and some parasites

persist even longer. New processing methods such as modified-atmosphere packaging also create food safety concerns because increased storage times permit *Listeria monocytogenes*, which thrives in cold temperatures, to grow while the product is refrigerated (10). The need to change food safety behavior based on these many factors is often difficult to convey to consumers who have never become ill from doing things the "old way."

At the same time, calls to USDA's Meat and Poultry Hotline 1-800-535-4555 show that consumers repeatedly are asking very basic questions about how to handle, prepare and store food (14). Although new food safety messages based on current developments must be developed and shared, they must go hand in hand with basic food safety information that is timeless. The importance of hand washing is a good example.

The development of food safety messages is further challenged by the fact that although our surveillance systems for foodborne illness are improving rapidly, the majority of cases of foodborne illness lack an identified etiology. The most recent and comprehensive data on foodborne illnesses in the United States (15) documents the large percentage of foodborne outbreaks reported to the Centers for Disease Control and Prevention (CDC)³ that are caused by pathogens or agents that have not yet been identified and thus cannot be diagnosed. The authors estimate that 62 million cases of gastrointestinal illness of unknown etiology are due to foodborne disease transmission each year. This may seem surprising until one considers that many of the pathogens of greatest concern today, such as *Campylobacter jejuni* and *Escherichia coli* O157:H7, were not recognized as causes of foodborne illness only 20 years ago (15).

Despite the challenges, decades of experience with consumer messages and professional education about food safety demonstrate their importance in the overall strategy to reduce the incidence of foodborne illness. This experience has made educators smarter in terms of knowing how best to develop and target the educational activities to have the greatest effect. Food safety education cannot be a substitute for needed regulatory and research activities. But all three must go hand in hand as part of a farm-to-table, comprehensive strategy to reduce the incidence of foodborne illness.

Methods of assessment

A wide spectrum of surveillance methods can be used to monitor progress in reducing the incidence of foodborne illness. At one end of the spectrum, methods to assess knowledge and attitudes about food safety are helpful in determining whether basic information about how to handle, prepare and store food has reached consumers and other food handlers. But as health professionals well know, knowledge does not necessarily translate into action; that is why it is also necessary to evaluate food safety behavior.

On the more objective end of the spectrum, data on pathogens in foods provide valuable information on the exposure of individuals to certain foodborne pathogens, although other variables such as preparation and food handling can alter the link between levels of pathogens in a product and subsequent illness. The ultimate measure of progress in reducing food-

³ Abbreviations: CDC, Centers for Disease Control and Prevention; FDA, Food and Drug Administration; FMI, Food Marketing Institute; FSIS, Food Safety and Inspection Service; HACCP, Pathogen Reduction and Hazard Analysis and Critical Control Points; PFGE, pulsed-field gel electrophoresis; SE, *Salmonella* Enteritidis.

borne illness is public health outcome data that can be obtained through surveillance systems.

None of these four methods of assessment, i.e., knowledge and attitudes, food safety behavior, levels of pathogens in foods and foodborne illness data, is perfect. For example, surveys asking questions about food safety knowledge, attitudes and behaviors suffer from the reporting biases common to all such self-reported data. In the area of pathogen levels on foods, data are lacking for foods other than meat and poultry products, and information on levels for specific pathogens such as *Campylobacter* are lacking due to difficulties in analytic methodologies. Linking levels of pathogens in specific foods to the likelihood of illness is difficult because of the lack of dose-response studies and ethical constraints on conducting such studies. The newest data estimating the annual incidence of foodborne illness from the CDC indicate that a large proportion of diarrheal illnesses have no identified etiology (15). Despite these limitations, useful data have been obtained using all four methods of assessment.

Surveillance

Knowledge and attitudes. Surveys of the public's knowledge and attitudes demonstrate that progress has been made over the years, but that much work remains to be done. Interestingly, in light of the attention food safety has received in the media in recent years, many surveys show a high public awareness about food safety, but knowledge remains fair to poor. In a survey conducted by the Food Marketing Institute (FMI) in January 2000 on consumer attitudes and behaviors and the supermarket, researchers found that 91% of the participants rated food safety as very or somewhat important. Of the 2000 consumers interviewed by telephone, 27% thought that mishandling or poor sanitation was the most common cause of foodborne illness (16).

A 1998 Food Safety Survey conducted by the Food and Drug Administration (FDA) and the Food Safety and Inspection Service (FSIS) compared consumer knowledge in the years 1988, 1993 and 1998 and found that, in general, food safety knowledge increased (17). The most dramatic change was in consumers' knowledge about microbes. In 1993, 36% of those surveyed thought that microbes are a serious food safety problem, compared with 55% in 1998. In 1993, 84% of consumers surveyed knew about *Salmonella*, and by 1998, that had increased to 93%. There also was an increase in consumers' understanding of risks of leaving perishable foods at room temperature. In 1988, 21% of those surveyed thought meat left at room temperature for >2 h was safe; in 1998, only 8% made that mistake.

Food safety behaviors are somewhat more difficult to evaluate because they often are self-reported, and such reporting is often associated with biases (18). In the FMI survey, consumers were asked what they do to be sure the food they prepare at home is safe from germs. Sixty percentage of consumers said they wash their hands and food preparation surfaces often; 17% said they cook properly; 13% said they refrigerate foods; and 6% said they separate foods. The FDA-FSIS survey illustrates how repeated consumer behaviors changed over a period of 5 y, between 1993 and 1998. The number of consumers who did not wash cutting boards, did not wash hands and abused food temperature precautions decreased over that time. The reported consumption of raw eggs, raw oysters and raw hamburger, all considered to be high-risk behaviors, also decreased.

Few direct observations of food safety behaviors exist in the published literature. However, a 1997 audit of consumer food handling practices by Audits International was reported in the

February 1998 issue of *Food Technology* (19). Auditors observed food behaviors in 106 households located in 81 cities across the United States and Canada. This was a biased sample in that the individuals were highly educated, i.e., 73% had college degrees. Auditors used a critical control point approach similar to that conducted in restaurants. Even under a watchful eye, however, <1% of the households met minimum criteria for acceptable performance. Critical violations observed included cross-contamination, sick/symptomatic food handlers, hand washing neglected and improper cooling of leftovers. At least one critical violation was observed in 96% of households. This indicates that poor food safety practices are common, even among better-educated individuals. A follow-up 1999 survey conducted in different households showed some improvement, but critical violations were observed in 69% of the households. (20). Audits International plans to conduct a home food safety survey each year to monitor trends.

Research on knowledge and behaviors of foodservice workers in institutional settings, restaurants and retail food stores is surprisingly limited, but this is a major area of concern for a number of reasons. These include rapid turnover of employees and the difficulty this poses in terms of training, and the fact that food safety mistakes in large-scale feeding operations can have major ramifications, particularly for those patients in hospitals and nursing homes who are more susceptible to foodborne illness. In addition, epidemiologic data show that cross-contamination in retail operations has been responsible for outbreaks. In a study of outbreaks of *E. coli* O157:H7 at four chain steak and salad bar restaurants in Oregon and Washington, it was determined that cross-contamination from beef within the restaurant kitchens, where meats and multiple salad bar items were prepared, was the likely source of these outbreaks (21).

In September 2000, the FDA released a report of its retail food program database of foodborne illness risk factors. The report, which covered 900 institutional foodservice establishments, restaurants and retail food stores, showed that the risk factors in need of greatest attention were improper holding times and temperatures, contaminated equipment/cross contamination and poor personal hygiene. The report established a baseline with which to measure how effective industry and regulatory efforts are in changing behaviors and practices that relate directly to foodborne illness in the retail food industry against which future follow-up studies can be compared. (22).

Knowledge and attitudes related to food safety also are critical among health care professionals who have direct contact with patients. This is particularly important for those health care professionals providing care to that segment of the population most susceptible to foodborne illness. For example, healthy people do not often develop noticeable listeriosis symptoms after eating food containing *Listeria monocytogenes*. However, some people are very susceptible to the disease. During pregnancy, the illness can be transmitted to the fetus, causing spontaneous abortion or serious illness in newborns. Others most at risk include the elderly and patients with immune systems compromised by cancer, AIDS, immunosuppressive medications and chronic diseases. Although data are limited regarding the food safety knowledge of health care professionals, what little is available is not very encouraging. In a qualitative research project conducted by the International Food Information Council, for example, knowledge about listeriosis among obstetricians and gynecologists was very limited. Few physicians indicated that they discuss the need for safe food handling with their patients (23).

In the spring of 2000, eight sites of the Foodborne Disease

TABLE 1

Prevalence of Salmonella in products^{1,2}

Product	Performance standard	Large plant prevalence ³ first year	Large plant prevalence past year	Small plant prevalence ³ first year	Small plant prevalence past year	Combined prevalence (large and small plants) past year
	%	n (%)				
Broilers	20.0	(5697) 10.9	(6171) 8.0	(2193) 16.3	(3060) 13.	(9231) 9.9
Hogs	8.7	(1532) 6.5	(2200) 3.7	(825) 18.2	(1485) 13.	(3685) 7.7
Cows/bulls	2.7	(58) 0	(58) 0	(1276) 2.3	(1392) 1.7	(1450) 1.6
Steers/heifers	1.0	(222) 0	(328) 0.3	(591) 0.2	(574) 0.2	(902) 0.2
Ground beef	7.5	(1184) 4.8	(583) 9.1	(14,522) 4.3	(8427) 4.7	(9010) 5.0
Ground chicken	44.6	(23) 4.4	(159) 8.8	(318) 18.9	(265) 17.7	(424) 14.4
Ground turkey	49.9	(748) 36.4	(583) 9.8	(363) 27	(318) 30.2	(901) 30.0

¹ Source: (41)² First year covers January 1998–January 1999; past year covers July 1999–June 2000.³ First year prevalence for Large and Small establishments was calculated by using results from all samples collected for sets initiated and completed that year. Number in parentheses is number of samples.

Active Surveillance Network (Foodnet), www.cdc.gov/ncidod/dbmd/foodnet/, began administering a knowledge, attitudes and practices survey to physicians who serve adults “at-risk” for severe forms of foodborne diseases. These physicians include obstetricians, infectious disease physicians and oncologists. The primary goals of the survey are to determine the current role of health professionals as food safety educators and to identify possible barriers that may prevent health professionals from being food safety educators (24).

There is a great need for such surveys of food safety attitudes, knowledge and behavior to continue over time so that changes can be assessed and education efforts targeted accordingly.

Product data. Product data, that is, data on pathogens in foods, provides valuable information on the exposure of consumers to certain foodborne pathogens. FSIS conducts microbiological baseline data collection studies to identify and quantify pathogenic bacteria on meat and poultry produced under Federal inspection. Over time, baseline profiles provide a basis for measuring the effectiveness of food safety intervention strategies on microbial contamination of raw products. In addition, baseline data have been used by FSIS to set pathogen reduction performance standards for *Salmonella* that industry must meet for a variety of raw meat and poultry products (Table 1). The performance standards for raw products differ greatly from the zero-tolerance standards that have existed for some time for ready-to-eat products, which may not receive additional cooking. FSIS based the performance standards for raw products on what the industry could realistically achieve using current technology, with the intention of making the standards stricter as industry is able to achieve further reductions. Because there is a wide range of *Salmonella* prevalence for different types of raw products, the performance standards differ considerably by product.

FSIS conducts *Salmonella* testing of raw meat and poultry products to ensure that industry is meeting the performance standards; as a result, considerable data are now available on the prevalence of *Salmonella* in these products. Data collected continuously since 1998, when the new requirements became effective, indicate that plants have been able to achieve a level of *Salmonella* considerably below the performance standards in many cases. On the basis of the encouraging data indicating a

trend toward decreased *Salmonella* prevalence, FSIS will explore adjusting the standards accordingly.

The FDA, which regulates foods other than meat, poultry and processed eggs, also collects data on microbial pathogens in food. The FDA is conducting surveys of fresh domestic and imported produce as part of its produce initiative to determine the incidence of microbial contamination in these commodities. (7).

Samples analyzed from product recalls also provide some information on the levels of pathogens in certain foods and may be helpful in determining dose responses when specific products can be tied to specific illnesses.

Epidemiologic data. Surveillance data on foodborne illness is the fourth data type and the most helpful in terms of identifying the burden of foodborne illness and the etiology for those illnesses. Until recently, foodborne illness surveillance data relied on physicians and state health departments to report cases to the CDC. Such “passive” reporting suffers from underdiagnosis and underreporting. Fortunately, surveillance data systems on foodborne illness have improved greatly in recent years and are providing us with very helpful information. In 1994, the Council for State and Territorial Epidemiologists declared *E. coli* O157:H7 as a reportable infectious disease, and all but two States require physicians to report new cases (25). In July 1995, CDC, FDA, FSIS and several state and local health departments began a collaborative project, Foodborne Diseases Active Surveillance Network (FoodNet), to collect more precise information on the incidence of foodborne disease in the United States. The objectives of FoodNet are as follows: to determine the frequency and severity of foodborne diseases; to determine the proportion of common foodborne diseases that result from eating specific foods; and to describe the epidemiology of new and emerging foodborne pathogens. FoodNet is an “active” surveillance system, meaning that public health officials frequently contact laboratory directors to find new cases of foodborne diseases and report these cases to the CDC. FoodNet has expanded as a result of funding by the President’s Food Safety Initiative; today, nine sites are included, covering a population of 25.4 million persons, or 10% of the U.S. population (26).

In September 1999, the CDC released new data that represent the most complete estimate to date on the incidence of

TABLE 2

Estimated illnesses, hospitalizations and deaths caused by known foodborne pathogens, United States

Disease or agent	Illnesses			Hospitalizations			Deaths		
	Total	Foodborne	% of total foodborne	Total	Foodborne	% of total foodborne	Total	Foodborne	% of total foodborne
Bacterial									
<i>Bacillus cereus</i>	27,360	27,360	0.2	8	8	0.0	0	0	0.0
Botulism, foodborne	58	58	0.0	46	46	0.1	4	4	0.2
<i>Brucella</i> spp.	1554	777	0.0	122	61	0.1	11	6	0.3
<i>Campylobacter</i> spp.	2,453,926	1,963,141	14.2	13,174	10,539	17.3	124	99	5.5
<i>Clostridium perfringens</i>	248,520	248,520	1.8	41	41	0.1	7	7	0.4
<i>Escherichia coli</i> O157:H7	73,480	62,458	0.5	2168	1843	3.0	61	52	2.9
<i>E. coli</i> , non-O157 STEC	36,740	31,229	0.2	1084	921	1.5	30	26	1.4
<i>E. coli</i> , enterotoxigenic	79,420	55,594	0.4	21	15	0.0	0	0	0.0
<i>E. coli</i> , other diarrheogenic	79,420	23,826	0.2	21	6	0.0	0	0	0.0
<i>Listeria monocytogenes</i>	2518	2493	0.0	2322	2298	3.8	504	499	27.6
<i>Salmonella typhi</i>	824	659	0.0	618	494	0.8	3	3	0.1
<i>Salmonella</i> , nontyphoidal	1,412,498	1,341,873	9.7	16,430	15,608	25.6	582	553	30.6
<i>Shigella</i> spp.	448,240	89,648	0.6	6231	1246	2.0	70	14	0.8
Staphylococcus food poisoning	185,060	185,060	1.3	1753	1753	2.9	2	2	0.1
Streptococcus, foodborne	50,920	50,920	0.4	358	358	0.6	0	0	0.0
<i>Vibrio cholerae</i> , toxigenic	54	49	0.0	18	17	0.0	0	0	0.0
<i>V. vulnificus</i>	94	47	0.0	86	43	0.1	37	18	1.0
<i>Vibrio</i> , other	7880	5122	0.0	99	65	0.1	20	13	0.7
<i>Yersinia enterocolitica</i>	96,368	86,731	0.6	1228	1105	1.8	3	2	0.1
Subtotal	5,204,934	4,175,565	30.2	45,826	36,466	59.9	1458	1297	71.7
Parasitic									
<i>Cryptosporidium parvum</i>	300,000	30,000	0.2	1989	199	0.3	66	7	0.4
<i>Cyclospora cayetanensis</i>	16,264	14,638	0.1	17	15	0.0	0	0	0.0
<i>Giardia lamblia</i>	2,000,000	200,000	1.4	5000	500	0.8	10	1	0.1
<i>Toxoplasma gondii</i>	225,000	112,500	0.8	5000	2500	4.1	750	375	20.7
<i>Trichinella spiralis</i>	52	52	0.0	4	4	0.0	0	0	0.0
Subtotal	2,541,316	357,190	2.6	12,010	3219	5.3	827	383	21.2
Viral									
Norwalk-like viruses	23,000,000	9,200,000	66.6	50,000	20,000	32.9	310	124	6.9
Rotavirus	3,900,000	39,000	0.3	50,000	500	0.8	30	0	0.0
Astrovirus	3,900,000	39,000	0.3	12,500	125	0.2	10	0	0.0
Hepatitis A	83,391	4,170	0.0	10,841	90	0.9	83	4	0.2
Subtotal	30,833,391	9,282,170	67.2	123,341	21,167	34.8	433	129	7.1
Grand Total	38,629,641	13,814,924	100.0	181,177	60,854	100.0	2718	1809	100.0

¹ Source: Mead (15).

foodborne disease in the United States. Overall, these data indicate that foodborne diseases appear to cause more illnesses, but fewer deaths than reported previously. According to the new data, diseases caused by food may cause an estimated 325,000 serious illnesses resulting in hospitalizations, 76 million cases of gastrointestinal illnesses and 5000 deaths each year. These estimates include mild cases of foodborne illness that may not result in a physician visit and thus would not be reported though the health care system. Three pathogens, i.e., *Salmonella*, *Listeria* and *Toxoplasma*, are responsible for 1500

deaths each year, >75% of those caused by known pathogens (Table 2).

These data represent a baseline against which future efforts to improve food safety can be measured. They cannot be compared with previous data because the new estimates are the result of better information and new analyses. In addition, they include some diseases that were not included in previous estimates. Thus, the data cannot be used to say the problem of foodborne illness is getting better or worse, but they may allow such statements to be made in the future. The data support

what has been known all along, i.e., that the burden of foodborne illness is substantial.

Because scientists are better able to quantify the effect of foodborne diseases on health, they also are learning more about the nature of that effect. For example, experts used to think foodborne illness was limited to an acute illness. But it is now known that infections can cause chronic complications as well. It is estimated that chronic sequelae may occur in 2–3% of foodborne disease cases and that the long-term consequences may be more detrimental than the acute disease (4). Examples of such associations are *E. coli* O157:H7 with hemolytic uremic syndrome, *Campylobacter* with Guillain-Barré syndrome and *Salmonella* with reactive arthritis. FoodNet conducts surveillance for hemolytic uremic syndrome through pediatric nephrologists, and in 1998 reported a total of 52 cases from FoodNet sites (28). In addition, FoodNet plans to collect data on chronic conditions such as Guillain-Barré syndrome and arthritis, to increase our understanding of the extent of chronic complications associated with foodborne illness (personal communication, Tamar Lasky, FSIS, 2000).

New technologies such as pulsed-field gel electrophoresis (PFGE), also known as DNA “fingerprinting,” allow us to gather more data on the specific etiology of foodborne illness cases. PulseNet is a national network of public health laboratories that perform DNA fingerprinting on bacteria that may be foodborne. The network permits rapid comparisons of these fingerprint patterns through an electronic database at CDC (28). This enables public health experts to link specific food products to specific human illnesses and to link what appear to be sporadic cases to a common source. Such associations have been made in a number of recent foodborne illness outbreaks, enabling public health officials to intervene more rapidly to limit the scope of the outbreak.

Although surveillance efforts discussed so far address microbial contamination, which is considered the most significant hazard associated with food, systems also are in place to monitor the safety of food from chemical contaminants. For example, the FDA approves new animal drugs for use in food-producing animals and monitors their use through surveillance and compliance programs (29). In addition, the FDA and FSIS share the responsibility for monitoring the food supply for chemical contaminants (30). Occasionally, special studies are conducted by Federal agencies to address a specific problem, such as recent studies conducted to determine levels of dioxin in foods.

Strategies for improvement

Strategies for improvement require the involvement of everyone with a responsibility for food safety, i.e., government, industry and the public. The surveillance systems discussed above will continue to guide public health agencies in terms of what new prevention and control strategies are required and will help to document the effectiveness of food safety strategies already in place.

Risk analysis framework. Federal agencies and others involved in food safety are finding it very useful to use a risk analysis framework as a means of organizing available information, identifying data gaps, quantifying food safety problems and presenting strategies for improvement. The risk analysis framework is composed of three parts, i.e., risk assessment, risk management and risk communication (Fig. 1). Risk assessment is a structured process for determining the risks associated with any type of hazard, biological, chemical or physical, in a food. Risk management is the process of weighing policy alternatives in light of the results of risk assessment and

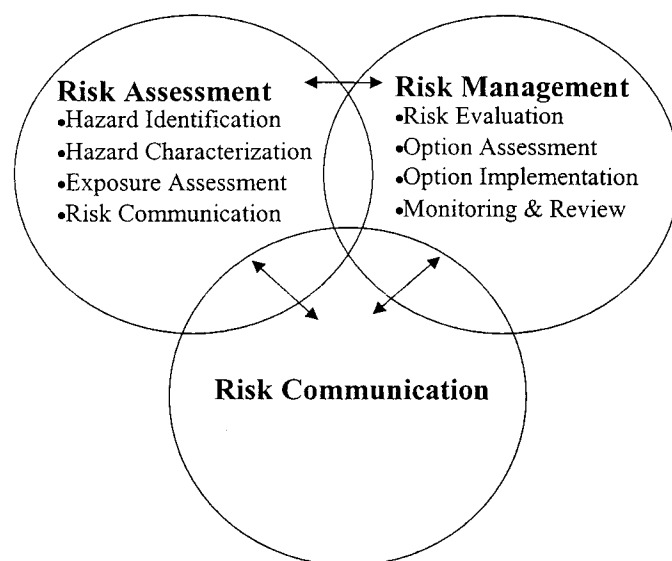


FIGURE 1 Structure of risk analysis. Food and Agriculture Organization (43).

selecting and implementing appropriate control options. Risk communication is the exchange of information and opinions on risk among risk assessors, risk managers and other interested parties, including the general public. It is a way in which managers can communicate with the public about the nature of actions they have taken and provide information on how to reduce illnesses. In fact, this framework was used to develop the strategic plan for Federal food safety activities that is being developed through the President's Council on Food Safety (31).

Risk assessment. One challenge of conducting risk assessments for microbial pathogens is that unlike chemical, environmental or toxicological contaminants, bacteria can multiply and produce toxins as conditions change. In addition to this technical difficulty, many data gaps exist. For example, little information is available to estimate accurately the relationship between the quantity of a microbial pathogens and subsequent illness. Despite these challenges, researchers are developing predictive models to estimate risk for certain pathogens and certain foods.

In 1998, FSIS, in cooperation with other Federal agencies and academia, completed a farm-to-table, microbial risk assessment for *Salmonella* Enteritidis (SE) to quantify the risks associated with eggs and egg products. Epidemiologic data from the CDC showed that there was an increasing problem with infections of SE associated with these products. This was the first farm-to-table, quantitative risk assessment ever conducted for a microbial pathogen (32).

As a result of the risk assessment, public health officials know more about the incidence of illness attributed to SE in shell eggs and egg products. Although a very small percentage of eggs, 1 in 20,000, are contaminated, the implications for human health are quite significant in terms of illnesses. A contributing factor is the practice of pooling eggs for quantity food production, which increases exposure to an SE-contaminated egg.

A risk assessment is currently underway for *E. coli* O157:H7 in ground beef (33), and a risk ranking is underway for *Listeria monocytogenes* in ready-to-eat products (34).

Risk management. Once a risk assessment is completed, risk managers are better able to determine what steps are required to address the problem. On the basis of the risk

assessment conducted for SE in eggs and egg products, for example, the President's Council on Food Safety determined that a strategic plan to address egg safety had to be carried out on a faster track than the broader strategic plan already underway for all foods. *Egg Safety from Production to Consumption: An Action Plan to Eliminate Salmonella Enteritidis Illnesses Due to Eggs*, which was developed with extensive public input, was released in December 1999 (35). It identifies the risk management and communication steps required to reduce, and ultimately eliminate eggs as a source of SE illnesses. The Federal agencies involved are now developing proposed regulations and taking other steps to implement the action plan.

In a perfect world, formal, quantitative risk assessments would be conducted before any risk management steps are taken. However, in the real world, risk management steps must be taken on the basis of incomplete information and adjusted as new information becomes available. A good example relates to *E. coli* O157:H7, a relatively new pathogen that was the cause of a major outbreak of foodborne illness attributed to undercooked ground beef patties served at a fast food restaurant chain in late 1992 and early 1993. FSIS did not conduct a formal risk assessment for the pathogen, but took a number of risk management steps to address the problem on the basis of epidemiological data. First, it declared *E. coli* O157:H7 an adulterant in ground beef and initiated a testing program for the pathogen. Second, the Agency began work on its landmark Pathogen Reduction and Hazard Analysis and Critical Control Points (HACCP) rule, which required plants to adopt the process control system known as HACCP to prevent all food safety hazards, including pathogenic microorganisms (36). HACCP was developed in the 1960s to ensure the safety of food eaten by U.S. astronauts in space. Under HACCP, plants identify critical control points at which hazards can occur during their processes, establish controls to prevent or reduce those hazards and maintain records documenting that the controls are working as intended. In addition, the rule established pathogen reduction performance standards for *Salmonella* that slaughter plants and grinding operations must meet to verify that their HACCP systems are effective in reducing contamination with pathogenic microorganisms. All plants that slaughter and process meat and poultry are now operating under these requirements.

New technologies such as irradiation and steam pasteurization are important risk management strategies in the food safety arena. FSIS, in concert with FDA, has approved the use of irradiation to treat a number of meat products to reduce pathogens. The latest approval was for refrigerated or frozen uncooked meat to control *E. coli* O157:H7 (37).

Risk communication

Food safety education is essential to the government's risk analysis approach to reducing foodborne illness, and the inclusion of food safety in the *Dietary Guidelines* will facilitate this goal. Such education is required for all individuals involved in the food safety farm-to-table continuum to ensure that they meet their responsibilities for food safety. This includes producers, growers, transporters, workers in various segments of the food processing industry, retail food service workers, consumers, regulators and health professionals.

Fortunately, the President's Food Safety Initiative and the President's Council on Food Safety have identified professional and consumer education as integral parts of the overall strategy to reduce foodborne illness. Therefore, a number of partnerships to improve food safety knowledge and behavior have already been established, and many food safety resources

are available currently for professionals to use. Partnerships are especially important in extending available resources, capitalizing on unique opportunities for reaching the public and removing barriers between groups and organizations that might otherwise have conflicting food safety concerns and training needs.

The Food Safety Training and Education Alliance for Retail, Food Service, Vending, Institutions, and Regulators, the result of the President's Food Safety Initiative, shares food safety education materials and conducts joint education activities in order to leverage resources. The Alliance carries out activities related to professional education, including reviewing food safety training materials, encouraging research pertaining to food safety training and education, identifying the need for food safety training and education in foreign languages, and expanding food safety and training partnerships among government, industry and academia (38).

The National Food Safety System Steering Committee, formerly known as the "50-State Project," is bringing together government food safety officials nationwide to encourage the integration of food safety activities, including education, at all levels of government (39).

The Partnership for Food Safety Education, a public-private partnership composed of >25 Federal agencies and private organizations involved with food safety, successfully launched and continues to promote the Fight BAC! consumer education campaign (40). Tens of thousands of educators and health professionals have received materials for distribution, and surveys conducted for the Partnership by Yankolovich, in 1998 and 1999, indicate that 13% of the U.S. population is aware of the campaign. Anecdotal data provided by locally based educators show a correlation between improved food safety behavior and exposure to Fight BAC! materials or programs. The Canadian Partnership for Consumer Food Safety Education, www.canfightbac.org, is an official Fight BAC! international partner, and other countries are using the messages and materials as well.

Many food safety resources have been developed through these and other partnerships and by individual groups and are available to educators and health professionals. The materials, and the messages they contain, are based on scientific data and behavioral research. The goal is to develop messages that are technically accurate, but at the same time simple, clear and action oriented. For the future, FSIS will continue to work through these partnerships and use new scientific information to develop educational campaigns. These activities include educational strategies to reach individuals at risk of foodborne illness and the health professionals and family members who work with them.

FSIS recently began a nationwide educational campaign to instruct consumers on the importance of using a food thermometer with foods such as hamburgers for which it is critical to know that a safe internal temperature of the foods has been reached. This was particularly necessary in light of results from a 1998 study by the Agricultural Research Service indicating that ~25% of ground beef patties turn brown before they have reached the safe internal temperature of 160°F (41). This indicates that color by itself cannot be depended on by consumers to determine the safety of a hamburger. The renewed focus on thermometers culminated recently with the kick-off of an educational campaign involving Thermys, and the message "It's Safe to Bite When the Temperature is Right." The campaign was designed through focus group testing, with strong support from consumers, educators, industry and health professionals (www.fsis.usda.gov/Thermy).

New communications strategies will help spread the word

by making access possible and affordable for large segments of the population. The National Food Safety Strategic Plan includes a state-of-the art national food safety information network. The network will promote the exchange of information, provide online food safety training and access to interactive Web sites with downloadable educational files and materials to facilitate dissemination (31).

The inclusion of food safety in the *Dietary Guidelines for Americans* will go a long way toward ensuring that the public has access to a safe and nutritious food supply.

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